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Abstract

PROBLEMS RELATED WITH THE POWER REGULATION OF REACTORS BY PHYSICO-CHEMICAL METHODS, AND THE BEHAVIOUR OF WATER AND HEAVY WATER IN NUCLEAR REACTORS

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The observation of the behaviour of water and heavy water in working reactors contributes to their safe running and provides information useful in studies relating to reactivity control techniques using soluble poisons.

The use of nuclear poisons dissolved in the water of a reactor leads to its chemical pollution. The conditions under which they can be used without causing the undesirable effects of this pollution are studied. Problems of analysis, although important, are not tackled in this paper.

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Behaviour of heavy water in working reactors.

1° - Isotopic pollution of heavy water : The rate at which this pollution occurs depends on the type of reactor and on certain characteristic incidents. The use of a reconcentration column is an efficient way of maintaining the heavy water isotopic concentration in a reactor which cannot be considered exempt from slow isotopic pollution.

2° - Heavy water leak detection : The instantaneous rates of small leaks can be measured, the leak localised, and the atmospheric contamination in the reactor building checked. Isotopic analysis for deuterium, or tritium determination, is carried out on samples.

3° - Chemical pollution and purification of heavy water : Chemical pollution of heavy water is one of the most complex problems in reactor chemistry. Corrosion of the materials which make up the core and the heavy water circuits varies extensively with the state of purity of the heavy water, as may be appreciated from the performances of the purification circuits and from direct measurements. From the knowledge acquired it has been possible to work out standards of purity which, if observed, will guarantee satisfactory running of the reactor.

4° - Radiolytic decomposition of heavy water : A better knowledge of its quantitative aspects in reactors is necessary in order to foresee the amounts of explosive gas mixture given off in power reactors. The radiolysis rate develops with the chemical purity of the water and the instantaneous power of the reactor. Experience of the CEA heavy water reactors and a systematic study of the radiolytic decomposition of water in the core of swimming-pool reactors are described.

Setting up of reactivity control by physico-chemical methods

1° - Reactivity control by homogeneous poisoning of the reactor : A comparison of the evolution of xenon poisoning with the residual antireactivity of the poison in solution during its nuclear consumption establishes the pro-

gramme which must govern the variation in its concentration if the exact compensation is to be produced.

The behaviour of the poison towards the reactor materials under the particular operational conditions must be taken into account.

2° - Radiolytic decomposition of water in the reactors in the presence of soluble poisons : A study of the effect of certain chemically inert salts, present in small concentrations in the water, on its radiolytic decomposition rate, has led to some new results which are discussed.

3° - The choice of a soluble poison is justified on the basis of the above results.

4° - Reactivity control by the use of a gaseous absorbant : The use of a "gas control rod" circuit for compensation purposes, in place of solid control rods is described.

The use of soluble poisons in the moderator to compensate the xenon effect, and of a gaseous absorbant in a circuit known as a "gas control rod", form original aspects of the reactivity control in the reactor EL 4.